Dr. Morsy
- DC Generator
- DC motor
- synch. Gen. AC 3 phase

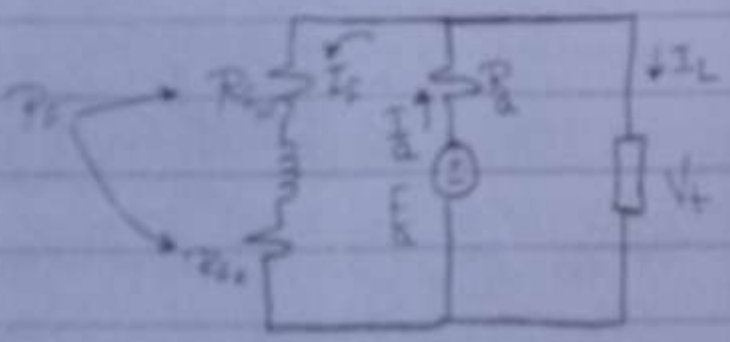
Dr Fath
- transformer
- induction 3ph
[illegible]

- DC Generator
  - stator (stationary part) (field ct)
  - rotor (rotating part) (Armature ct)

4 types:

1- Seperately Excited
V.I.P ★★ 2- shunt Generator
3- series Generator
★ 4- Compound Generator

[illegible]
1 Shunt Generator

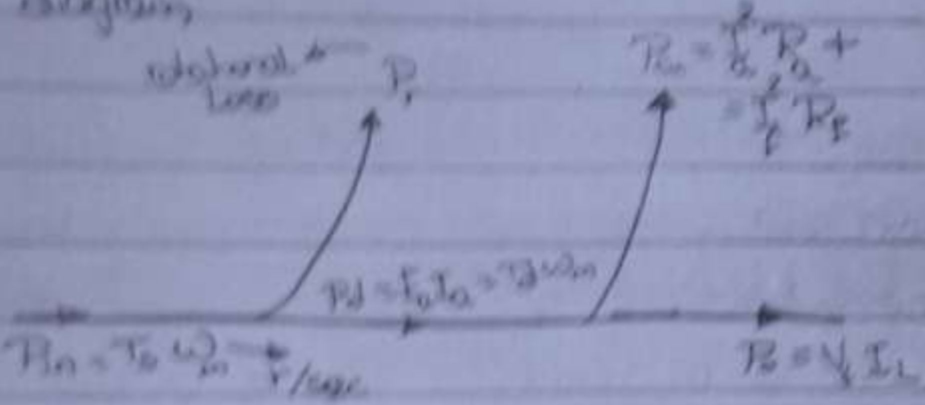


$$E_a = V_t + I_a R_a$$

$$I_a = I_L + I_f$$

$$V_t = I_f (R_{fx} + R_{fw})$$

power flow diagram



rotational loss
P_r
$P_{cu} = I_a^2 R_a + I_f^2 R_f$
$P_d = E_a I_a = T_d \omega_m$
$P_{in} = T_s \omega_m$
r/sec
$P_o = V_t I_L$

where T_s → shaft torque "I/p" → applied

T_d → developed Torque

$$\omega_m = \frac{2\pi N_m}{60}$$

Ex. midterm

E_a → induced emf "No load voltage"

V_t → terminal voltage

[illegible]

40kw = P_o

V_t = 100V

R_a = 0.085 Ω → armature resistance

R_{sh} = 25 Ω

R_{fx} = 15 Ω

N_m = 1000 rpm

P_r = 4 Kw

Determine : ① E_a ② P_d ③ T_s ④ η

Sol.

$$E_a = V_t + I_a R_a$$

$$= 100 + (I_L + I_f) \times 0.085$$

$$R_f = R_{fw} + R_{fx} = 40\Omega$$

$$I_L = \frac{P_o}{V_t} = \frac{40*10^3}{100} = 400A$$

$$I_f = \frac{V_t}{R_f} = \frac{100}{40} = 2.5A$$

$$E_a = 100 + (402.5 * 0.085)$$
$$= 134.2V$$

$$P_d = E_a I_a$$
$$= 134.2 * 402.5 = 54.015 \ kw$$

$$P_{in} = P_r + P_d$$
$$= 4*10^3 + 54.015*10^3$$
$$= 108.03 \ kw$$

$$T_s = \frac{P_{in}}{\omega_m} = \frac{108.03*10^3}{\frac{2\pi*1000}{60}} = \checkmark \quad N.m$$

$$\eta = \frac{P_o \xrightarrow{} V_t I_L}{P_{in}}$$

Ex

DC shunt Generator driven at speed of 900 r.p.m. The Load draw a current $\overset{I_L}{\text{of}}$ 200A for a magnetic flux per $\overset{}{\underset{R_f}{\text{pole}}}$, as 0.1 wb. The armature ct $\overset{R_a}{\text{is}}$ 0.1 Ω field Resistance = 130 Ω, lap $\overset{a=P}{\text{connected}}$, armature Z conductors = 300.

→ For effeciency 80% find..

① VR% , ② I_f , ③ I_a , ④ P_r , ⑤ P_{cu} , ⑥ T_s

Note

→ flux per pole (wb)

$$E_a = K_a \phi_p \omega_m \longrightarrow \boxed{\frac{2\pi N_m}{60}}$$

$$K_a = \text{constant} = \frac{pZ}{2\pi a}$$

P → No. of poles
Z → No of conductors

a = 2 (wave connect)
a = p (Lap ")

N.B مثلاً لو قالك ان armature cond. = 300 في ده
No of slot = 30 slot & 10 conductors

Sol

$$E_a = \frac{PZ}{2\pi a} * 0.1 * \frac{2\pi * 900}{60}$$

$$= 450\ V$$

$$V_t = E_a - I_a R_a$$

$$V_t = 900 - (200 + I_f) * 0.1$$

$$I_f = \frac{V_t}{R_f} = \frac{V_t}{130}$$

$$V_t = 900 - \left(200 + \frac{V_t}{130}\right) * 0.1$$

$$V_t = ✓$$

$$VR\% = \frac{E_a - V_t}{V_t} * 100 = ✓\ \%$$

$$I_f = \frac{V_t}{R_f} = \frac{420}{130} = 3.2\ A$$

$$I_a = 200 + 3.2 = 203.2\ A$$

$$\eta = \frac{P_o^{\,\longrightarrow V_t I_L}}{P_{in}}$$

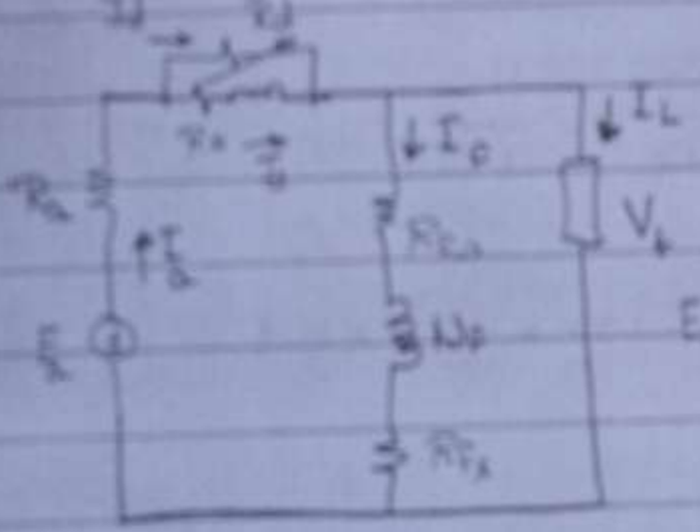
$$P_r = P_{in} - P_d^{\,\longleftarrow E_a I_a}$$

$$P_{cu} = I_a^2 R_a + I_f^2 R_f$$
$$= P_d - P_o$$

$$T_d = \frac{P_d}{\omega_m}$$

3 Compound Generator

(a) Long shunt.



I_d
R_d
R_s
I_s
R_a
I_a
E_a
I_f
R_{sh}
N_f
R_{Fx}
I_L
V_t

$R_d \longrightarrow$ diverter resistance

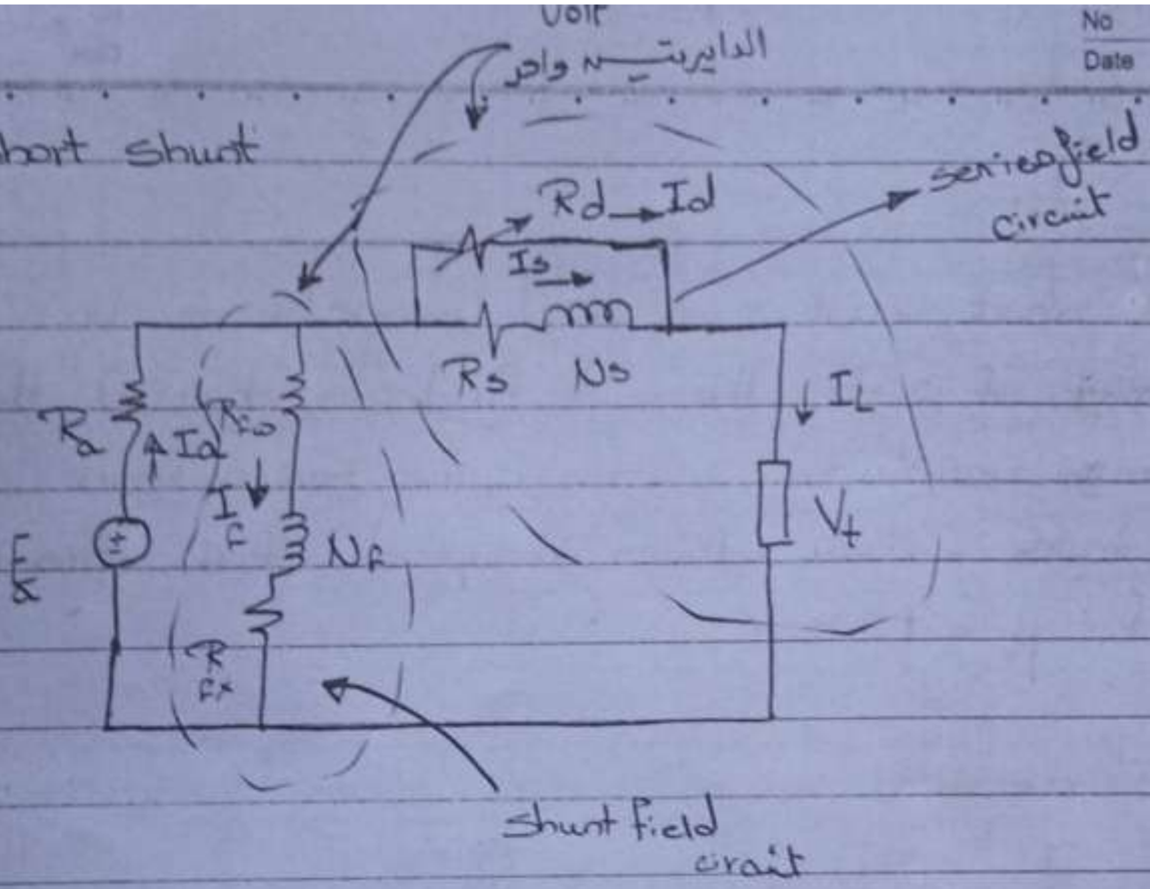
بنسميها long لأن
في مسافة بين الـ E_a
و الـ shunt

$\cong I_d R_d$ (حسب السؤال)

$$E_a = I_a R_a + I_s R_s + V_t \longrightarrow I_f R_f$$

$$I_a = I_d + I_s \Big) \cong$$
$$= I_f + I_L$$

ⓑ short shunt

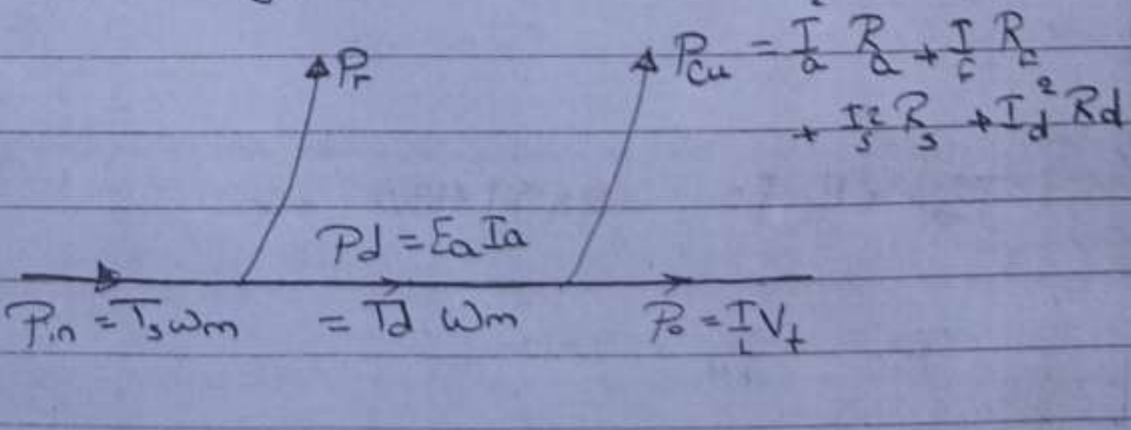

Volt
الدايرتين واحد
Rd
Id
Is
series field circuit
Rs
Ns
IL
Ra
Ia
Rco
If
Nf
Ea
Vt
Rfx
shunt field circuit

$$E_a = I_a R_a + \underbrace{I_s R_s + V_t}_{I_f R_f}$$

$$I_a = I_L + I_f$$

$$I_L \rightarrow I_s + I_d$$

* power flow diagram


P_r
$P_{cu} = I_a^2 R_a + I_f^2 R_f + I_s^2 R_s + I_d^2 R_d$
$P_d = E_a I_a$
$P_{in} = T_s \omega_m$
$= T_d \omega_m$
$P_o = I_L V_t$

Ex 3_14

$\overset{V_t}{240\,V}$ short shunt compound Generator is drawn acurrent of $\overset{I_L}{125A}$, the shunt field $\overset{I_f}{\text{current}}$ is 5A, the armature $\overset{R_a}{\text{resistance}}$ = 25mΩ, the series field

Rs resistance = 15mΩ driven at speed of 600 rpm

for P_r = 3 K.w

Determine..

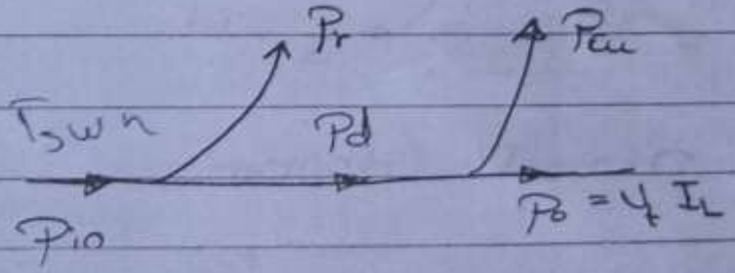
① η , ② T_s

Sol.

$$E_a = V_t + I_a R_a + I_s R_s$$

$$= 240 + (125+5) * 25*10^{-3} + 125*15*10^{-3}$$

$$= 245.1V$$



$P_d = E_a I_a = 245.1*130 =$ ✓

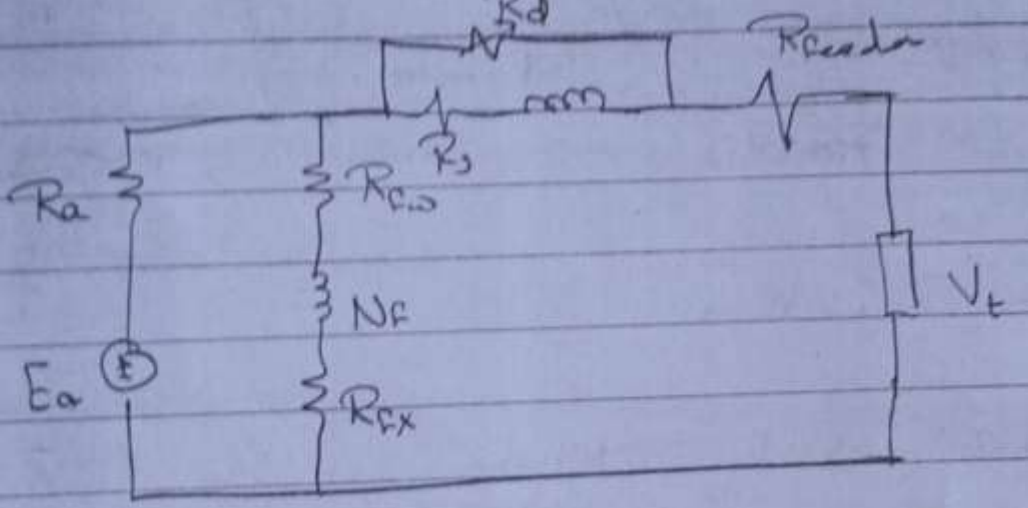
$P_{in} = P_d + 3*10^3 =$ ✓

$$\eta = \frac{P_o \xrightarrow{} V_t I_L}{P_{in}}$$

$$T_s = \frac{P_{in}}{\omega m}$$

ممكن يجيب يقولك انى ربط ال series ct بال V_t

بـ feeder


Rd
R_feeder
R_s
R_a
R_fw
N_f
E_a
R_fx
V_t

$$E_a = I_a R_a + I_s R_s + V_t + I_L R_{feeder}$$

$$P_{cu} = I_L^2 R_{feeder} + I_a^2 R_a + I_f^2 R_f + I_s^2 R_s + I_d^2 R_d$$

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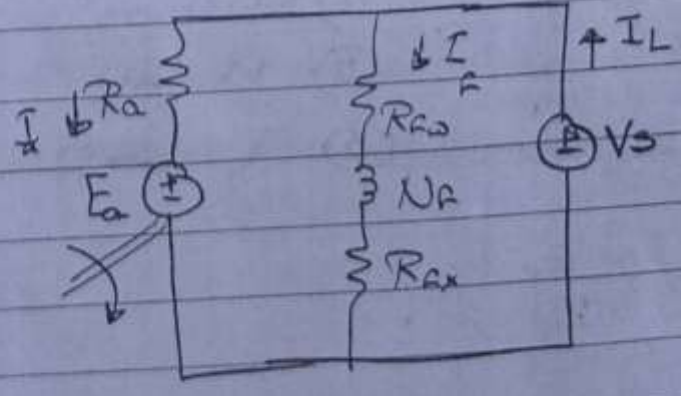
chapter 2

DC Motor

- shunt
- series
- compound

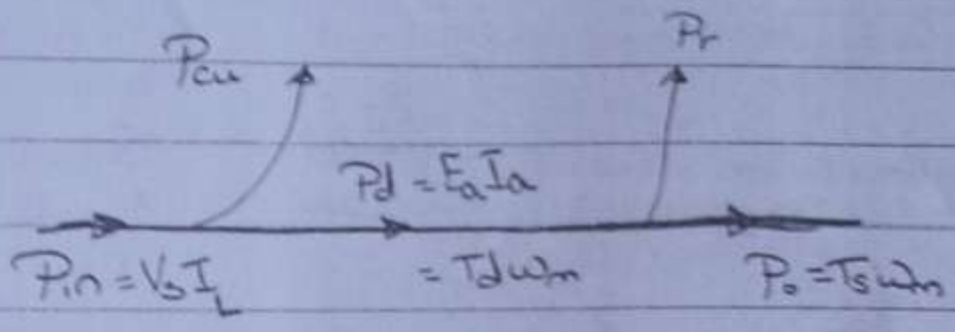
① shunt motor


I_a
R_a
E_a
I_f
R_fw
N_f
R_fx
I_L
V_s

$$V_s = I_f R_f \begin{cases} \to R_{fx} \\ \to R_{fw} \end{cases}$$

$$= E_a + I_a R_a$$

$$I_L = I_a + I_f$$


P_{cu}
P_r
$P_d = E_a I_a$
$= T_d \omega_m$
$P_{in} = V_s I_L$
$P_o = T_s \omega_m$

Speed Regulation

$$S.R\% = \frac{N_m|_{nL} - N_m|_{FL}}{N_m|_{FL}} * 100 = \; . \; \%$$

Examples

full load lotica $\qquad\qquad$ V_s

DC shunt motor drive a Load for supply voltage

I_a

240V. The armature current = 25A

The rated speed = 2200 rpm → $R_a = 0.8\,\Omega$

$R_F = 120\,\Omega$ $\qquad$ $N_m)_{FL}$

Calculate

① Machine const. $(K_a \Phi_p)$

② $N_m|_{nL}$

③ $T_s \rightarrow P_r = 100\,w$

Sol.

$E_a)_{fl, R} = K_a \Phi_p \omega_m)_{fl, R}$

$E_a)_R = V_s - I_a)_R R_a$

$= 240 - 25 * 0.8 = 220V$

$K_a \Phi_p = \dfrac{220}{\frac{2\pi * 2200}{60}} = 0.96 \; V/(rad/sec)$

Note

No Load

$P_d = P_r + P_{o \to 0}$ (as it is no load)

$P_d)_{nl} = P_r$

$\rightarrow E_a)_{nl} \; I_a)_{nl}$

$E_a)_{nl} = V_s - I_a)_{nl} R_a \qquad (* I_a)_{nl})$

$P_d)_{nl} = P_r = 100 \qquad \boxed{I_a)_{nl} E_a)_{nl}} = V_s - I_a^2)_{nl} R_a$

$100 = \cancel{240} - 240 \, I_a)_{nl} - 0.8 \, I_a^2)_{nl}$

$I_a)_{nl} = 299.5 \; A \rightarrow$ refused

$I_a)_{nl} = 0.417 \; A$

$E_a)_{nl}$ ←

No load.

$T_a \rightarrow$ ـه Full load عند الـ

power لو

noload → speed لو

$T_a \rightarrow P_o - P_r$ ← 100

↓

P_d

↙

$E_a)_{fl}\ I_a)_{fl}$

Example 4.5.

The $V_t = 120V$ DC shunt Motor has a no load of 4A at speed of 1200rpm the arm. resistance 0.8Ω R_a and shunt resistance = 60Ω

efficiency [illegible] no load → ?)$_3$ [illegible]

Find: ① efficiency and speed at rated load of 2.4kw

Sol.

$I_L)_{nl} = 4A$

$N_m)_{nl} = 1200$ rpm

at No Load

$P_d)_{nl} = P_r$

↙

$E_a)_{nl}\ I_a)_{nl}$

$E_a)_{nL} = V_s - I_a)_{nL} R_a$

$= 120 - (I_L - I_f) * 0.8$

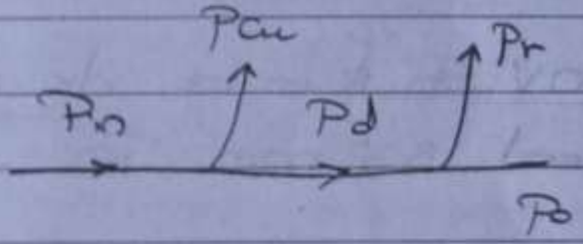
$= 120 - (4 - \frac{120}{260}) * 0.8 = 118.4V$

$P_d)_{nL} = P_r = 2 * 118.4 = 236.8 W$

at Full Load $\longrightarrow P_o = 24 kW$ ⟶ P_d

$P_r = 236.8 W$

$E_a)_{FL} = V_s - I_a)_{FL} R_a$



$\overset{2636.8}{\curvearrowleft} P_d)_{FL} = 120 \, I_a)_{FL} - I_a^2)_{FL} * 0.8$

$\longrightarrow I_a)_R = 26.75 A \longrightarrow E_a = 97V$

لما يطلع عندي قيمتين اخد الاولى

$I_L = I_a + I_f \leftarrow \frac{V_s}{R_f}$

$= 26.75 + 2 = 28.75 A$

$P_{in} = V_s I_L$

$E_a = K_a \Phi_p \, \omega_m)_{FL}$ ⟶ عامل يعتمد على IF

$E_a \propto \omega_m$

$$E_a)_{nL} \leftarrow \frac{E_{a1}}{E_{a2}} = \frac{N_{m1}}{N_{m2}} \leftarrow N_m)_{nL}$$

$E_a)_{fL} \leftarrow E_{a2}$ $\qquad$ $N_{m2} \leftarrow N_m)_{fL}$

$$\frac{118.4}{97} = \frac{1200}{N_m)_{fL}}$$

$$N_m)_{fL} = \sim$$

Ex 4-6

220V (V_s) shunt motor draws a current of 10A (I_L) at a speed 1800 rpm, $R_a = 0.2\,\Omega$, $R_f = 440\,\Omega$, $P_r = 180\,W$

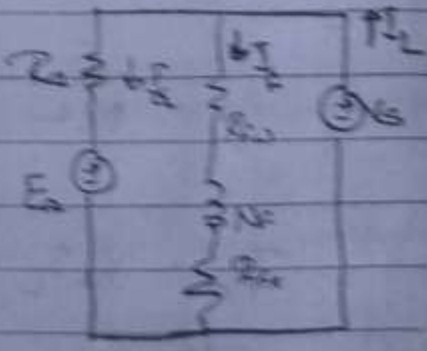
determine

① E_a $\qquad$ ② T_s, T_d, η

لو [illegible] الكفاءة في Full و no load

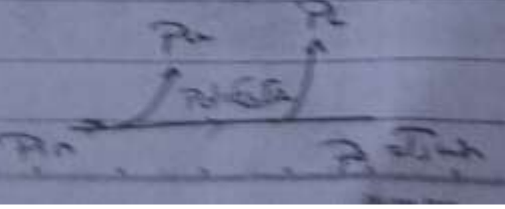
Sol.

$$E_a = V_s - I_a R_a$$
$$= 220 - (\overset{10}{I_L} - \overset{0.5}{I_f}) * R_a$$
$$= 218\ V$$


R_a
I_a
I_f
I_L
E_a
V_s
R_{fw}
N_f
R_{fx}

$$P_d = E_a I_a$$
$$= 213 * 9.5 = \sim w$$

$$P_o = P_d - P_r$$


P_{in}
P_{cu}
P_L
$P_d = E_a I_a$
$P_{in} = V_s I_L$

o/p torque ← $T_s = \frac{P_o}{\frac{4\pi * 1800}{60}}$ = [illegible]

↓

or general shaft torque

$P_{in} = I_L V_s = 220 * 10$

$\eta = \frac{P_o}{P_{in}}$

$T_d = \frac{P_d}{\omega_m} = 11\ N.m$

Ex 4-7

نفس معطيات المسألة اللي فاتت

$T_{d_2} = 20\ N.m$

Find ① N_{m2} ③ η

② I_{L2}

Sol.

$E_a = K_a \Phi_m \omega_m$

$\boxed{T_d = K_a \Phi_p I_a} \rightarrow I_f$ ([illegible])

$T_d \propto I_a$

$$\frac{T_{d1}}{T_{d2}} = \frac{I_{a1}}{I_{a2}}$$

$$\frac{11}{20} = \frac{9.5}{I_{a2}}$$

$I_{a2} = 17.3A$

$I_{L2} = I_f + I_{a2}$

$= 0.5 + 17.3$

$= 17.8\ A$

$E_a \propto N_m$

$$\frac{E_{a1}}{E_{a2}} = \frac{N_{m1}}{N_{m2}}$$

$$\frac{213.1}{E_{a2}} = \frac{1800}{N_{m2}}$$

$E_{a2} = V_s - I_{a2} R_a$

$= 220 - 17.3 * 0.2$

$= ✓$

$N_{m2} = ✓$

$$\eta = \frac{P_o}{P_{in}}$$

$$P_{in2} = V_s I_{L2}$$

$$= 220 * 17.8 = \checkmark \text{ watt}$$

~~[illegible]~~

$$P_o = P_{d2} - \overset{\swarrow 180}{P_r}$$

$$P_{d2} \searrow E_{a2} * I_{a2}$$

P_r ثابتة لو مغيرهاش

لو قالك ان $\rightarrow$ $\frac{P_{r1}}{P_{r2}} = \frac{N_{m1}}{N_{m2}}$

P_r بيتغير

$$P_{r2} = \checkmark$$

Sketch speed / current c/cs

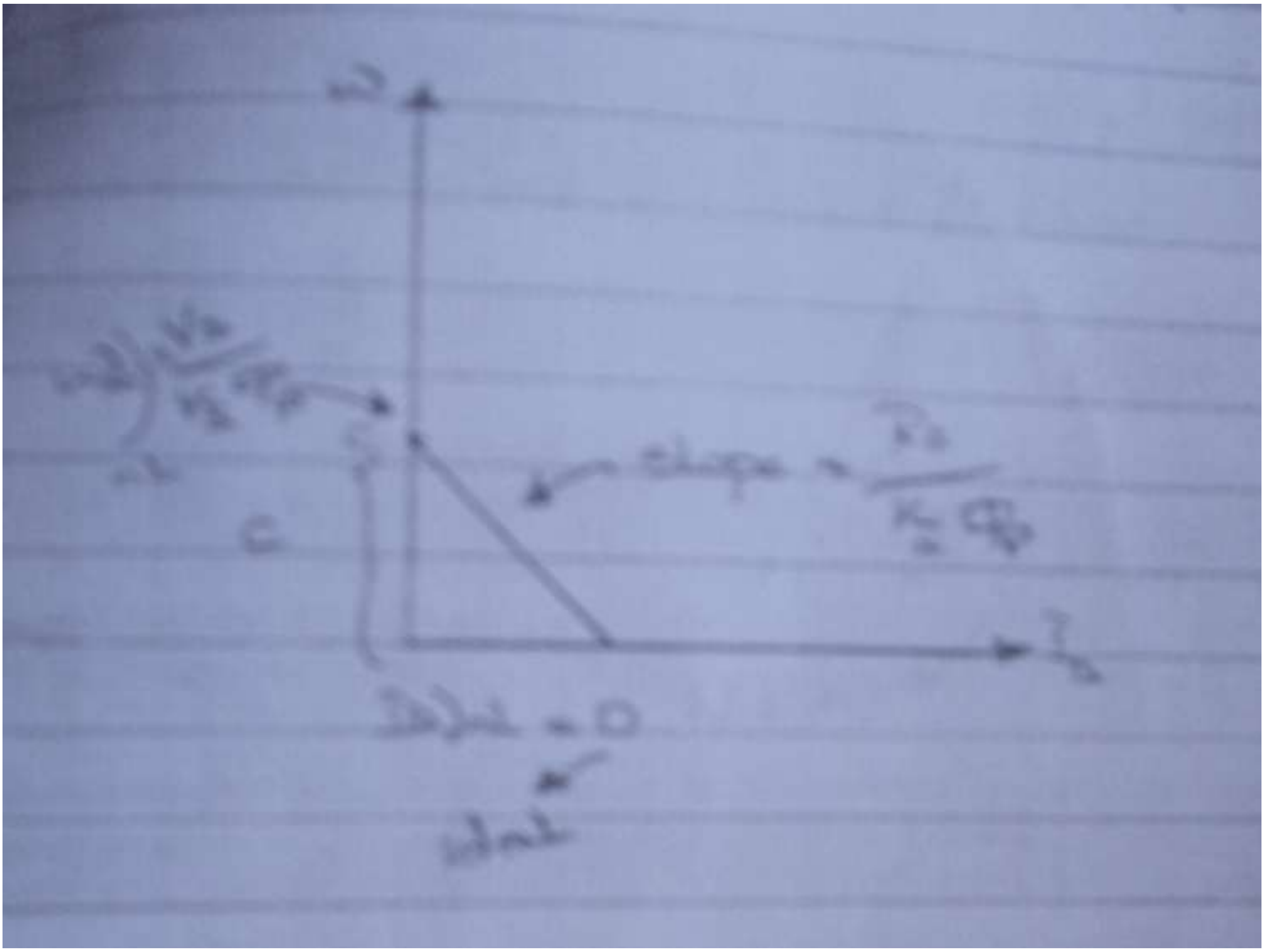
$$E_a = K_a \Phi_p \omega_m$$

$$= V_s - I_a R_a$$

$$K_a \Phi_p \omega_m = V_s - I_a R_a$$

$$\omega_m = \frac{V_s}{K_a \Phi_p} - \frac{R_a}{K_a \Phi_p} I_a$$

$$\boxed{Y = C - mX}$$


ω
slope =
C
= 0
Ideal

http://www.com-dep.tk